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Preoperative Embolization Therapy for Esophageal Operation

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Background and Objectives: Since 1993, we have performed preoperative embolization therapy (PET) in an attempt to augment the blood flow of the gastric tube and prevent anastomotic leakage after esophageal resection. The clinical effects and complications associated with PET are reported.
Methods: The femoral artery was punctured and the left gastric artery, right gastric artery, and splenic artery underwent embolization, leaving the right gastroepiploic artery as the only patent feeding artery for the stomach. PET was performed in 54 patients, and data concerning blood flow of the stomach before and after the construction of the gastric tube were available in 51 patients. Of the 25 patients who were operated in the same period without undergoing PET, similar data were available in 20 patients.
Results: In the group of patients who underwent PET, the blood flow of the gastric tube after its construction was 67% of the value measured at the upper part of the stomach just after opening the abdominal cavity. For those who were not pretreated by PET, it declined to 33%.
Conclusions: PET for esophageal cancer is a safe procedure that contributes to the decrease in the frequency of anastomotic dehiscence after esophageal operation, owing to the augmented tissue blood flow of the upper portion of the stomach following the construction of gastric tubes.
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KEY WORDS: **esophageal cancer; anastomotic leakage; arterial embolization**

INTRODUCTION

Anastomotic dehiscence is one of the most menacing complications following surgery for esophageal cancer [1–4]. Of the four modes of reconstruction—antesternal, retrosternal, retromediastinal, and intrathoracic—the antesternal reconstruction is generally known to be associated with the highest incidence of anastomotic leakage [5]. Nevertheless, it has been preferred over the other modes especially for the high-risk patients due to the fact that the management of anastomotic dehiscence, once it has occurred, is greatly facilitated following this mode of reconstruction. Lengthy hospitalization, however, is often needed before the resultant fistula closes, and several patients eventually suffer from recurrent disease before oral food intake can be started. Consequently, most of the recent cases have undergone intrathoracic or retromediastinal reconstruction, hence the reduced incidence of anastomotic leakage. Measurement of the stomach blood flow has revealed poor anatomic connection of blood flow between the right gastroepiploic artery and the short gastric artery in approximately 1/3 of the patients [6]. Routine surgical procedure of gastric tube construction induces impaired blood supply at the upper part of the gastric tube, resulting in decoloration at the point of anastomosis, which certainly leaves rooms for concern. Preoperative embolization therapy (PET) was devised to

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TABLE I. Esophageal Cancer: Patient Demographics

	PET (+)	PET (−)
Number of patients	54	25
Mean age (year)	59.6	63.8
Gender (Male:Female)	46:8	22:3
Operation		
Blunt dissection (%)	7 (13)	4 (16)
Rt thoracotomy (%)	47 (87)	21 (84)
Anastomosis		
Cervical (%)	18 (33)	7 (28)
Intrathoracic (%)	36 (67)	18 (72)
Neoadjuvant chemotherapy (%)	22 (41)	6 (24)

solve this problem. PET accomplishes preoperative embolization of feeding arteries for the stomach with the exception of the right gastroepiploic artery, induces a drastic change in the distribution of blood flow in the stomach, and enables the blood flow of the proximal stomach to be supplied through the only feeding artery to be left intact after the construction of the gastric tube.

MATERIALS AND METHODS

Patients with peptic ulcer and pancreatitis were considered not eligible for the procedure. For the rest of the patients who underwent esophageal resection at the Department of Surgery II, Nagoya University Hospital, after 1993, PET was considered as a standard procedure. PET was actually performed in 54 patients, but not in another 25 patients who underwent similar surgical procedure in the same period due to the limited capacity for angiography in the hospital. These 25 cases were considered as a control group. Fifty-one of the PET group and 20 of the control group underwent intraoperative measurement of tissue blood flow of the stomach. Of the PET group, blunt dissection was performed in 7/54 (13%) cases and cervical anastomosis in 18/54 (33%) cases. Of the control group, blunt dissection was performed in 4/25 (16%) cases and cervical anastomosis in 7/25 (28%) cases. Neoadjuvant chemotherapy was performed in 22/54 (41%) of the PET group and 6/25 (24%) of the control group. Two patients in the PET group underwent manual anastomosis (patients with total laryngectomy), and others underwent mechanical anastomosis with Premium-CEEA (U.S. Surgical Co., Norwalk, CT (Table I).

The femoral artery was punctured and celiac angiography was performed. The left gastric artery, right gastric artery, and splenic artery underwent embolization with MWCE embolization microcoil (Cook, Bjaeverskov, Denmark). The right gastric artery was originally occluded at a point beyond the second or third branch to the gastric wall, but it is now believed that embolization at the root of the right gastric artery is not liable to cause any problems. The patients were instructed to refrain from oral food intake for 1 day following the PET, with antibiotics and histamine-2 receptor antagonist given parenterally for 3 days.

The tissue blood flow of the stomach was measured twice, just after the abdominal cavity was opened and after the gastric tube was constructed, with a laser flow meter (model ALF 2100; Advance, Tokyo, Japan). The point used to measure blood flow was the upper part of the anterior wall of the stomach. The probe of a laser flow meter was gently mounted on the wall with a weight for stability, and the mean value of tissue blood flow 1 min. after the steady state was reached was calculated by Maclab (AD Instruments, Castle Hill, NSW, Australia).

RESULTS

Angiography After Embolization

Before embolization was performed, the major blood supply to the upper part of the stomach as observed by the angiogram was via the left gastric artery and the short gastric artery. A marked decrease in the blood flow and vascularity was observed in this region by the angiogram performed immediately after PET. These findings are considered to represent the vascular status of the gastric tube immediately after its construction in the patients who are not pretreated by PET (Fig. 1). The angiogram 3 weeks after PET reveals a dilated right gastroepiploic artery, with remarkable abundance in the blood flow in the upper part of the stomach (Fig. 2).

Tissue Blood Flow of Stomach During Operation

The average blood flow in the gastric tube was considerably greater at 8.0 ml/min/100 gm in the PET group as opposed to 6.4 ml/min/100 gm in the control group. The mean reduction rate of tissue blood flow in the stomach before and after the construction of the gastric tube was 33% in the PET group and 67% in the control group, showing a remarkable effect of PET in preserving the blood flow. A gastric tube with blood flow less than 5 ml/min/100 gm was observed in as much as 45% (9/20 cases) of the control group, while less frequently at 16% (8/51 cases) in the PET group. These gastric tubes with poor blood flow often represented itself with apparent discoloration in the control group. On the other hand, the color of the gastric tube was invariably good in the PET group regardless of the results of the flowmetric analysis. This finding suggests that the prevention by PET of abrupt reduction in blood flow during the operation, reflected by the decreased reduction rate of tissue blood flow before and after the construction of the gastric tube, preserves less abundant but consistent blood flow from the right and ultimately ensures enough blood supply for the gastric tube (Table II).

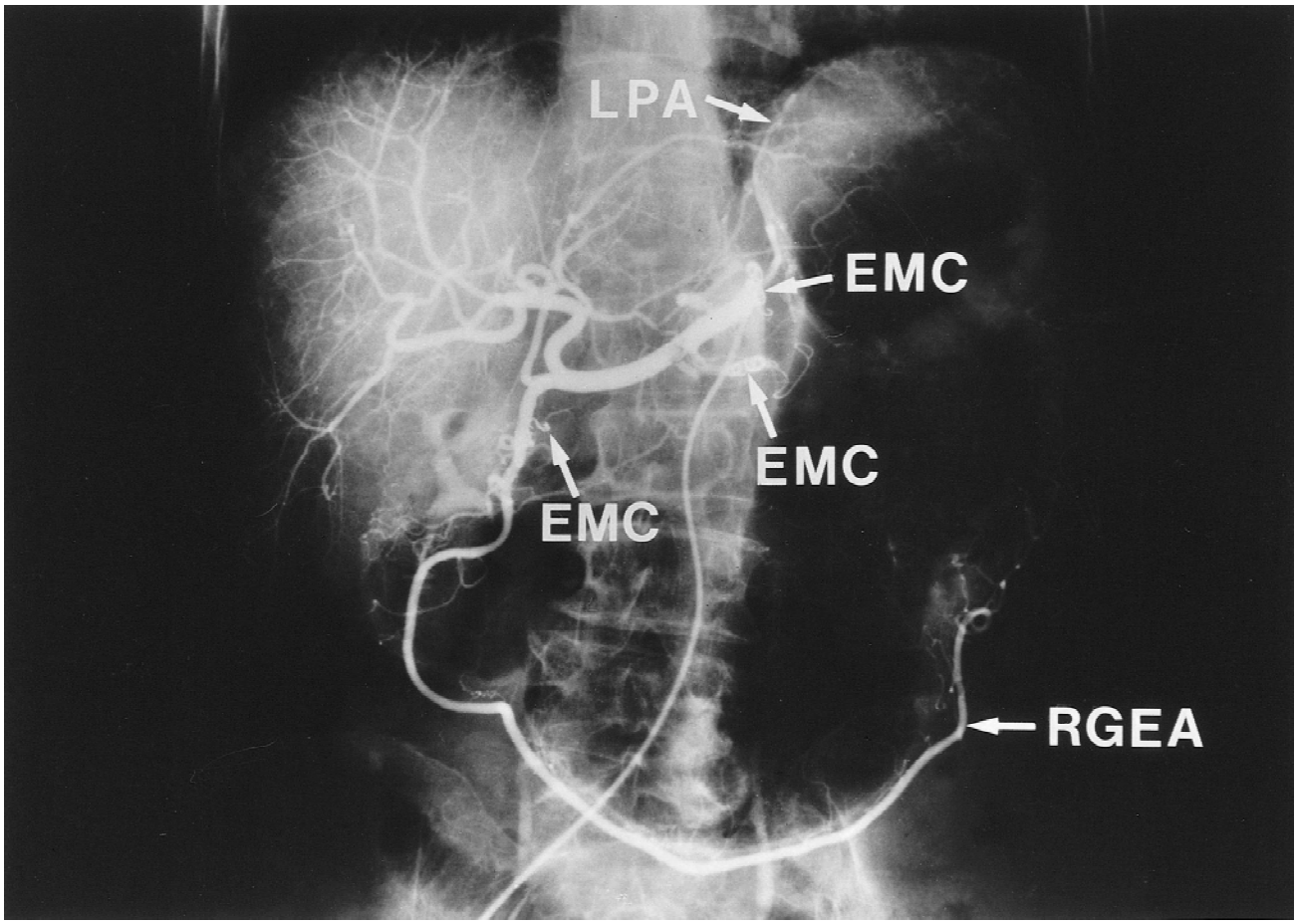

Fig. 1. Angiography just after preoperative embolization therapy (PET) (6 sec, 5 ml/sec). Blood supply to gastric tube during operation seemed to resemble the condition of this angiography. Anastomotic site was almost avascular. EMC = embolization microcoil; LPA = left phrenic artery; RGEA = right gastroepiploic artery.

Side Effects

Many patients experienced mild epigastric or left upper quadrant pain following PET (30/54, 56%). Severe pain was observed in patients who underwent embolization of the splenic artery at peripheral level rather than at the root (6%). Nausea was also encountered in most cases, and vomiting in 10 of 54 (19%) cases. There was a case of splenic necrosis forming infectious ascites that led to postoperative wound infection. Another case suffered from mass-forming pancreatitis of the portion distal to the point of embolization. These complications were the results of embolization beyond the root of the splenic artery. Embolization of the right gastric artery was not performed in two patients due to anomalies. In one case, recanalization of the left gastric artery was observed during operation. Extravasation was observed in two patients when performing embolization of the left gastric artery. In these patients, severe inflammatory changes remained at the time of surgery but did not lead to serious complications (Table III).

Anastomotic Leakage

Anastomotic leakage was observed in 2/25 of the control group (8%) as opposed to 1/54 of the PET group (2%). These results support convincingly the benefit of performing PET, considering the greater incidence of patients undergoing neoadjuvant chemotherapy among the PET group. The only patient who had anastomotic leakage among the PET group was operated on in 1993 after the neoadjuvant administration of 5-fluorouracil and cisplatin, amounting to a total dose of 14,000 mg and 200 mg, respectively. No anastomotic leakage has occurred in the PET group in the past 5 years.

DISCUSSION

The dismal prognosis of the patients with esophageal cancer makes it highly desirable that the postoperative course be uneventful. Anastomotic dehiscence, among various complications following esophageal surgery, often results in morbidity, prolonged hospital stay, and impairment of the quality of life. Neoadjuvant therapies

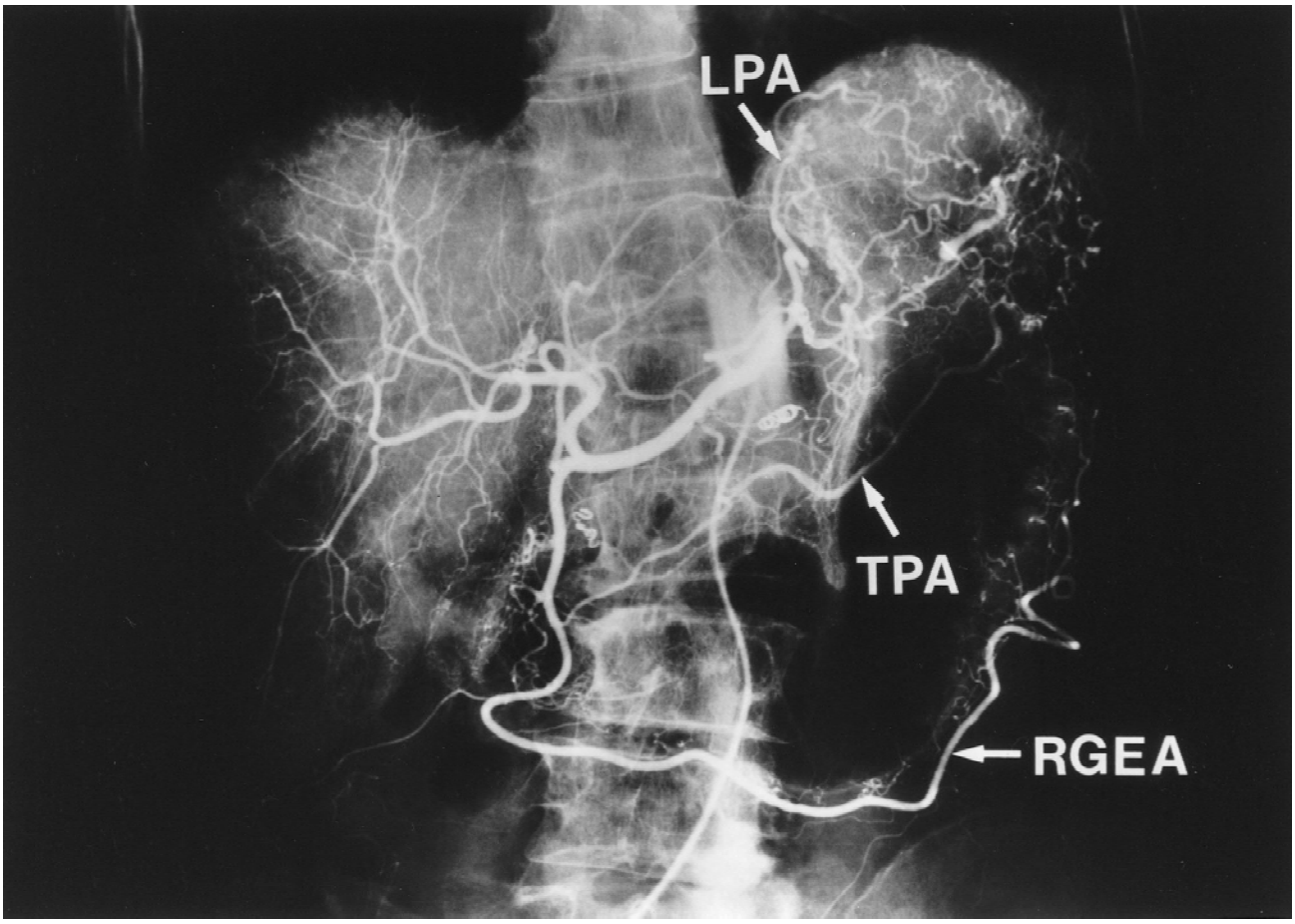

Fig. 2. Angiography 3 weeks after preoperative embolization therapy (PET) (6 sec, 5 ml/sec). Right gastroepiploic artery (RGEA) was dilated, and blood flow to cardia was increased. TPA = transverse pancreatic artery.

TABLE II. Gastric Tissue Blood Flow in Patients With Esophageal Cancer*

	Patient number	Blood flow (ml/min/100 g)		Blood flow preservation (%)	Blood flow less than 5 ml/min/100 g (%)	Leak
		Gastric tube	Stomach			
PET (+)	51	8.0	11.9	67	8 (16)	1
PET (−)	20	6.4	19.5	33	9 (45)	2

*Blood flow of the stomach was not measured in eight cases due to the trouble with a flow meter.

consisting of chemotherapy and radiation have become increasingly popular in several institutions, further raising the risk of surgical complications. Recently, there has been an increase in the number of institutions that perform intrathoracic reconstruction as a standard procedure, with consequent decrease in the incidence of anastomotic leakage. Measuring the tissue blood flow of the stomach, however, revealed some patients with poor anatomic connection of blood flow between the two major feeders, the right gastroepiploic artery and the short gastric arteries [6]. In these patients, construction of the gastric tube without preoperative alteration of the blood flow may result in impaired blood supply of the proximal stomach, leading to anastomotic dehiscence.

The aim of PET is to manipulate the blood flow of the proximal stomach, substituting the original blood flow mainly from the left gastric and short gastric arteries with a new supply from the right gastroepiploic artery, thus preventing an abrupt fall in the blood flow at surgery, which requires dissection of the left, right, and short gastric arteries. We believe the newly established blood supply to the anastomosis that originates from the right gastroepiploic artery to be a key to the prevention of anastomotic leakage. It is preferred to time the operation to be done more than 1 week after PET because of better preservation of tissue blood flow in the stomach [6]. Furthermore, alteration of vasculature by PET is found to reduce the collateral blood flow between the spleen and

TABLE III. Side Effects of Preoperative Embolization Therapy in Study Group of 54 Patients

Side effects	Number (%)
Abdominal pain	30 (56)
Fever	21 (39)
Vomiting	10 (19)
Extravasation	2 (4)
Splenic necrosis	1 (2)
Infection	1 (2)
Recanalization	1 (2)
Pancreatitis	1 (2)

stomach and facilitate the construction of the gastric tube in patients with liver cirrhosis.

Embolization of the splenic artery has been performed on patients with liver cirrhosis as a treatment for hypersplenism [7,8]; its side effects have been reported as infrequent and not life threatening. While embolization at the root of the splenic artery maintains blood supply to the spleen via the pancreas, embolization at the peripheral level has induced some unwanted complications in our series. Extravasation is another complication of PET that affect the subsequent surgery by inducing inflammatory changes around the vascular structure. The incidence of these complications, however, can be kept to a minimum if the procedure is performed by experienced radiologists. Further experience with PET will be accumulated with an ultimate goal of reducing the incidence of anastomotic leakage to 0%.

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